EP 20573 (7)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 675 605 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number : **95302103.7**

(51) Int. Cl.[6] : **H04B 1/40**, H04B 7/005

(22) Date of filing : **29.03.95**

(30) Priority : **30.03.94 US 219772**

(43) Date of publication of application :
04.10.95 Bulletin 95/40

(84) Designated Contracting States :
AT DE ES FR GB IT NL SE

(71) Applicant : **NOKIA MOBILE PHONES LTD.**
P.O. Box 86
SF-24101 Salo (FI)

(72) Inventor : **Heinonen, Jarmo**
Hirsmaentie 4
SF-24280 Salo (FI)
Inventor : **Hulkko, Jaakko**
Geologintie 6
SF-90570 Oulu (FI)
Inventor : **Vilmi, Toivo**
Iikanpiha 6
SF-90830 Haukipudas (FI)

(74) Representative : **Frain, Timothy John et al**
Patent Department
Nokia Mobile Phones
St Georges Court
St Georges Road
Camberley, Surrey GU15 3QZ (GB)

(54) Dual mode transmission system.

(57) A dual mode transmitter circuit is disclosed including a non-linear high-power amplifier having an amplification that can be adjusted and a linear high-power amplifier. A first switch and a second switch are connected to the input and output of the linear, high-power amplifier. An amplification-adjustable, high-frequency transmitter control amplifier is connected to the input of the non-linear high-power amplifier. Means for measuring transmission power such as a directional coupler is connected to the second switch, and a duplex filter is connected to the directional coupler. A power level control circuit is responsive to the measured transmission power from the directional coupler and to a power level signal. The power level signal is representative of the desired output power of the transmitter. The power level control circuit compares the measured power level from the directional coupler with the desired power level and produces a difference signal on its output lead which is connected to both the non-linear high-power amplifier and to the high-frequency transmitter control amplifier. A mode selection signal, for designating either an analog or digital type transmission mode is applied to a mode control circuit that is responsive to the mode selection signal and provides switching signals to the first and second switches and a control signal to the linear amplifier. The mode selection signal sets the transmitter to function in either the non-linear transmission (analog) mode or the linear transmission (digital) mode.

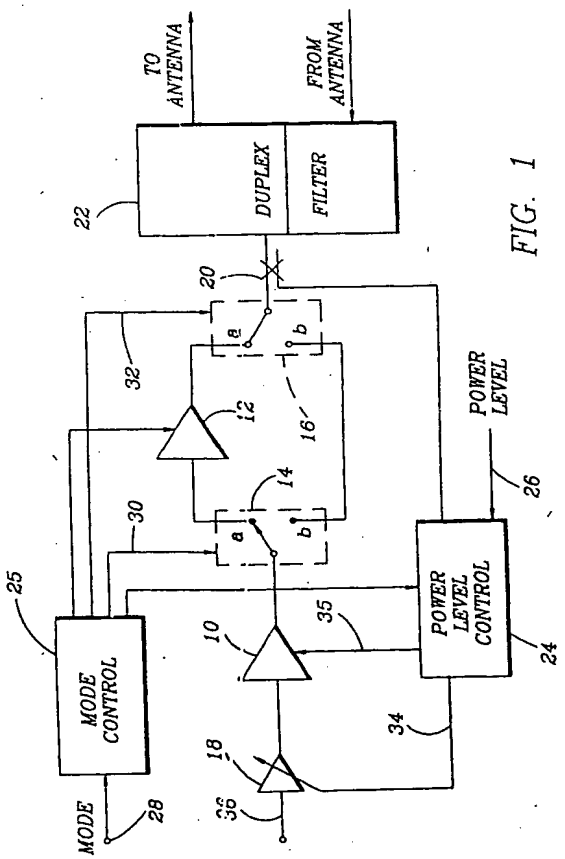

FIG. 1

EP 0 675 605 A2

The present invention relates to dual mode radio frequency transmission systems.

It is difficult to provide a radio frequency transmitter for use in mobile phone systems for broadcasting both equal and non-equal amplitude high-frequency signals by means of the same device (e.g. the DAMPS and CDMA transmission systems to be referred to here as dual mode mobile phone systems) which will achieve highest possible efficiency in both operational modes. This is an especially serious problem in the case of hand-held phones, which require a high-efficiency transmitter in all modes of operation in order to provide a long operating time and to minimize warming caused by waste heat.

The conventional solution of employing a linear transmitter in which the same transmitter is used to amplify both equal and non-equal amplitude signals, results in poor efficiency, particularly in the case of transmissions which use equal amplitude signals.

One solution previously used in the art for dual mode transmission to improve efficiency is to provide a circuit in which the operating point of the transmitter (and thereby its efficiency) is adjusted in accordance with the signal to be transmitted. In the case of the amplification of an equal amplitude signal, the operational category is adjusted to class C, for example, which provides a high efficiency.

The present invention aims to provide a dual mode transmitter which produces a good efficiency in the case of both equal and non-equal amplitude transmissions.

Accordingly, in one aspect, the present invention provides a dual mode signal transmission system of the type wherein modulated signals are transmitted in a digital or analog mode comprising a first amplification means having controllable amplification gain response to a modulated signal transmission; a power measuring means connected to the output of said first amplification means for providing a signal representative of said system actual transmission power level; an output means including a filter and antenna means for transmitting said modulated signal; a linear amplifier; a mode control signal for specifying a non-linear analog transmission mode and a linear digital transmission mode; and means for selectively disconnecting said first amplification means from said power measuring means and for connecting said linear amplifier between first amplification means and said power measuring means in response to said mode control signal.

In a second aspect, the present invention provides a dual mode signal transmission system comprising a signal input and a signal output which are coupled to each other by a signal path; the system further comprising, in the signal path, a first amplification means having a controllable frequency response; a power measuring means coupled to the output of the first amplification means and providing a signal representative of the actual system transmission power level; the system further comprising a linear amplifier switchable into and out of the signal path according to a mode control signal.

The present invention has application to the field of mobile phones.

Subsidiary aspects of the invention are given in the appended claims.

The drawing illustrates a schematic block diagram of an exemplary embodiment of a dual mode transmitter according to the principles of the present invention.

Referring to the drawing, a dual mode transmitter circuit is illustrated including a high-power amplifier means 10 having an amplification that can be adjusted and a linear high-power amplifier 12. A first switch 14 and a second switch 16 are connected to the input and output of amplifier 12. An amplification-adjustable, high-frequency transmitter control amplifier 18 is connected to the input of amplifier 10. Means 20 for measuring transmission power such as a directional coupler is connected to switch 16, and a duplex filter 22 is connected to means 20.

A power level control means 24 is responsive to the measured transmission power from means 20 and to a power level signal on lead 26. Power level signal on lead 26 is representative of the desired output power of the transmitter. The power level control means 24 compares the measured power level from means 20 with the desired power level on lead 26 and produces a difference signal on its output leads 34 and 35 and provides the difference signal on leads 34 and 35 to both the high-power amplifier 10 and to the high-frequency transmitter control amplifier 18.

The output of high power amplifier 10 can be controlled via the power amplification operating point, the operating voltage or the input operating power.

A mode selection signal, for designating either an analog or digital type transmission mode is applied to terminal 28. A mode control means 25 is responsive to the mode selection signal on terminal 28 and provides switching signals to switches 14 and 16 and a control signal to linear amplifier 12. Thus, the mode selection signal applied to terminal 28 sets the transmitter to function in either the non-linear transmission (analog) mode or the linear transmission (digital) mode.

The modulated signal to be transmitted is applied to the input terminal 36 of control amplifier 18, and passed through high-power amplifier 10. If switches 14 and 16 are set in the "a" position, which is the position for the digital transmission mode, the modulated signal from amplifier 10 is connected to and passes through linear high-power amplifier 12, through power measurement means (differential coupler) 20 and through duplex filter 22 where it is connected to an antenna (not shown) for transmission.

For the non-linear, or analog mode of transmis-

sion, an analog mode designating control signal is applied to terminal 28. In response, mode control means 25 provides signals on leads 30 and 32 which set switches 14 and 16 to the "b" position, thereby disconnecting and removing linear, high-power amplifier 12 from the transmission path between amplifier 10 and duplex filter 22. The output of amplifier 10 is connected through coupler 20 to filter 22. Amplifier 12 is in a non-active state. Amplifier 10 is operated near or at it's saturation non-linear region to achieve high enough output power and high efficiency.

The output power of the transmitter is controlled by adjusting either the amplifier 10 input power or the operating voltage of an output transistor contained in amplifier 10.

For the linear, or digital mode of transmission, the mode control signal at terminal 28 designates a digital transmission mode and causes mode control means 25 to provide signals on leads 30 and 32 to place switches 14 and 16 in the "a" position wherein the output of amplifier 10 is connected to the input of linear amplifier 12. The overall output power from amplifier 18 and amplifier 10 has been set so low, that amplifiers 18 and 10 effectively operate in a linear manner, for example with a-6dB back-off, meaning that the input power of an amplifier is adjusted such that the output power is some 6dB below the 1dB compression point and thus the amplifier is operates in a linear mode. Amplifier 12 receives such a low power RF level input signal that it operates in a linear mode, that is, in class A.

Thus, in the transmission system of the present invention transmission power is adjusted in both the analog and digital modes by measuring the output transmission signal power with the directional coupler 20 and comparing it with the desired output transmission power on lead 26 at the power level control means 24. A differential signal is used as a correction signal and is fed back to amplifiers 18 and 10.

A significant feature of the present invention is that the same structures can be used in both the analog and digital modes and that the output power in the analog mode can be adjusted by regulating the gain of gain controllable amplifier 18, or the amplifier 10 bias point or adjusting the amplifier 10 operating point, or in some implementations, the supply voltage. In the digital mode the output power can be adjusted only be regulating the gain of the gain controllable amplifier 18.

What has been described is a dual mode transmitter structure that operates in an analog or a digital mode depending on the state of a mode control signal. A linear amplifier is connected in series into the transmission signal path in the digital mode. It should be understood that the switches are logical functions and need not be implemented by physical switches. The switches 14 and/or 16 may be replaced in other implementations, for example by power divider(s).

While the invention has been described in connection with a particular embodiment, it is not intended to limit the scope of the invention to the form set forth, but, on the contrary, it is intended to cover such alternatives, modifications and equivalence as may be included within the scope of the invention as defined in the appended claims.

Claims

1. A dual mode signal transmission system of the type wherein modulated signals are transmitted in a digital or analog mode comprising a first amplification means (10,18) having controllable amplification gain response to a modulated signal transmission;

   a power measuring means (20) connected to the output of said first amplification means for providing a signal representative of said system actual transmission power level;

   an output means (22) including a filter and antenna means for transmitting said modulated signal;

   a linear amplifier (12);

   a mode control signal (28) for specifying a non-linear analog transmission mode and a linear digital transmission mode; and

   means (14,16,30,32,25) for selectively disconnecting said first amplification means (10,18) from said power measuring means (20) and for connecting said linear amplifier (12) between first amplification means (10,18) and said power measuring means in response to said mode control signal (28).

2. A dual mode signal transmission system according to claim 1 wherein said linear amplifier (12) is disconnected from said first amplification means (10,18) and said power measuring means (20) in response to a mode control signal specifying a non-linear analog transmission mode, and

   wherein said linear amplifier (12) is connected between said first amplification means (10,18) and said power measuring means (20) in response to a mode control signal specifying a linear digital transmission mode.

3. A dual mode signal transmission system according to claim 2 further including means (26) for providing a signal representative of a desired transmission power level;

   power level control means (24) connected to said power measuring means (20) and to said signal therefrom representative of said system actual transmission power level and to said signal representative of a desired transmission power level for comparing said active and desired lev-

el signals for producing a differential control signal representative of their difference; and

means (34,35) for connecting said differential control signal from said power level control means (24) to said first amplification means (10,18) for controlling the output power of said first amplification means (10,18) to provide an actual transmission power level equal to said desired transmission power level.

4. A dual mode signal transmission system according to claim 2 wherein said first amplification means (10,18) is a non-linear amplification means, and wherein said non-linear first amplification means provides a non-linear modulated transmitted signal from said transmission system in said non-linear analog transmission mode.

5. A dual mode signal transmission system according to claim 2 wherein said linear amplifier (12) connected between said first amplification means and said power measuring means (20) provides a linear amplified and transmitted signal from said transmission system in said linear digital transmission mode.

6. A dual mode signal transmission system according to claim 2 wherein said power measuring means (20) is a differential coupler circuit.

7. A dual mode signal transmission system according to claim 4 wherein said first amplification means includes an amplification-adjustable, high frequency transmitter control amplifier (18) and a non-linear high-power amplifier connected (10) in series.

8. A dual mode signal transmission system according to claim 4 wherein said signal from said first amplification means (10,18) is adjusted to a high value to cause said first amplification means to operate in a non-linear mode in response to an analog mode control signal.

9. A dual mode signal transmission system according to claim 5 wherein the output from said first amplification means (10,18) is adjusted to a low value to cause said first amplification means to operate in a linear mode in response to a digital mode control signal.

10. A dual mode signal transmission system comprising a signal input (36) and a signal output which are coupled to each other by a signal path;

the system further comprising, in the signal path, a first amplification means (10,18) having a controllable frequency response; and a power measuring means coupled to the output of the first amplification means (20) and providing a signal representative of the actual system transmission power level;

the system further comprising a linear amplifier (12) switchable into and out of the signal path according to a mode control signal (28).

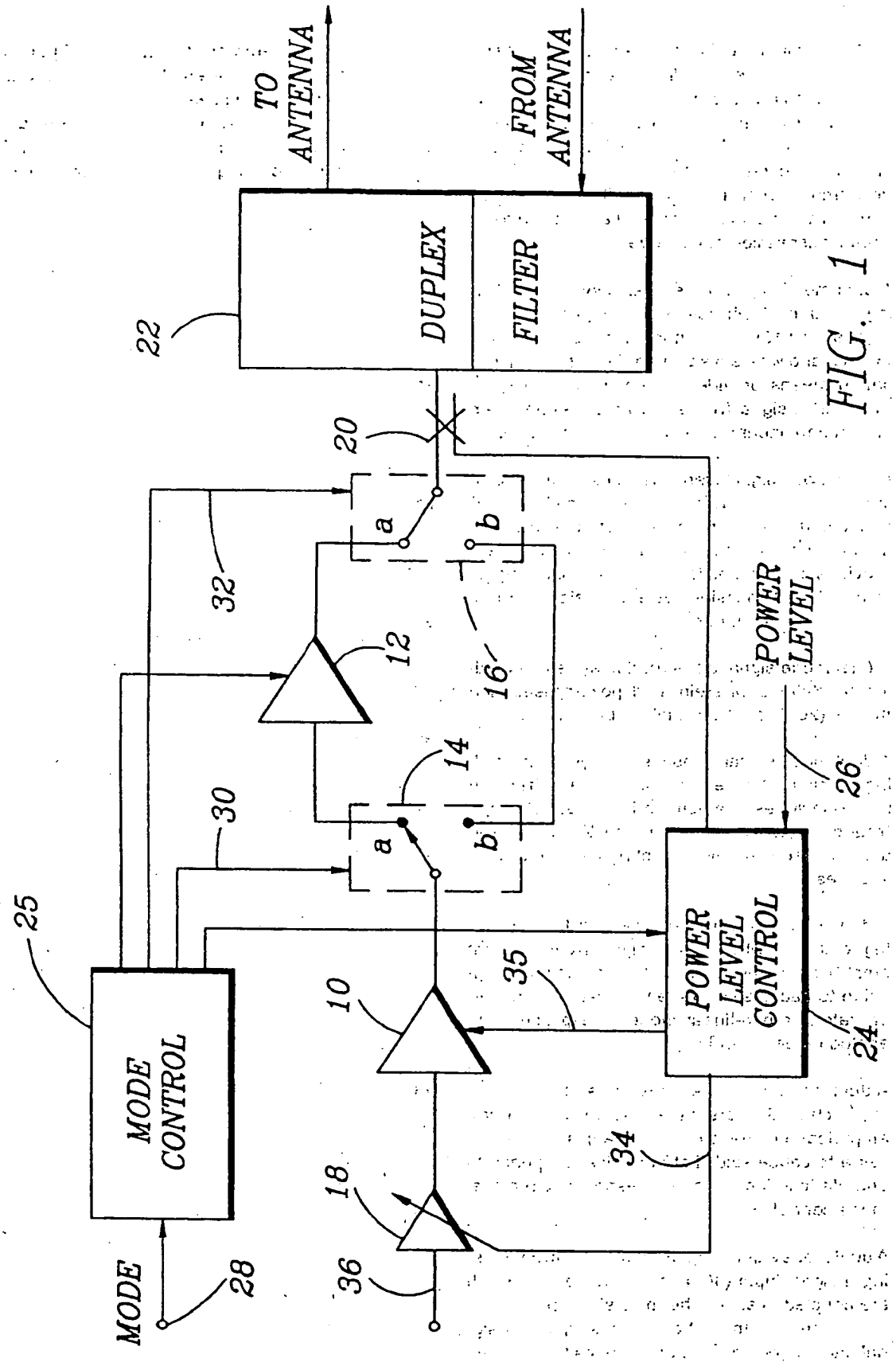
TO ANTENNA
FROM ANTENNA
DUPLEX FILTER
22
20
a
b
32
12
16
14
30
25
MODE CONTROL
10
35
POWER LEVEL CONTROL
24
26
POWER LEVEL
34
18
36
MODE
28

FIG. 1

THIS PAGE BLANK (USPTO)

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 675 605 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
21.07.1999 Bulletin 1999/29

(43) Date of publication A2:
04.10.1995 Bulletin 1995/40

(51) Int Cl.[6]: **H04B 1/40**, H04B 7/005

(21) Application number: **95302103.7**

(22) Date of filing: **29.03.1995**

(84) Designated Contracting States:
AT DE ES FR GB IT NL SE

(30) Priority: **30.03.1994 US 219772**

(71) Applicant: **NOKIA MOBILE PHONES LTD.**
24101 Salo (FI)

(72) Inventors:
- **Heinonen, Jarmo**
  SF-24280 Salo (FI)
- **Hulkko, Jaakko**
  SF-90570 Oulu (FI)
- **Vilmi, Toivo**
  SF-90830 Haukipudas (FI)

(74) Representative: **Frain, Timothy John et al**
Nokia IPR Department
Nokia (UK) Limited
Summit Avenue
Southwood
Farnborough Hampshire GU 14 0NZ (GB)

(54) Dual mode transmission system

(57) A dual mode transmitter circuit is disclosed including a non-linear high-power amplifier having an amplification that can be adjusted and a linear high-power amplifier. A first switch and a second switch are connected to the input and output of the linear, high-power amplifier. An amplification-adjustable, high-frequency transmitter control amplifier is connected to the input of the non-linear high-power amplifier. Means for measuring transmission power such as a directional coupler is connected to the second switch, and a duplex filter is connected to the directional coupler. A power level control circuit is responsive to the measured transmission power from the directional coupler and to a power level signal. The power level signal is representative of the desired output power of the transmitter. The power level control circuit compares the measured power level from the directional coupler with the desired power level and produces a difference signal on its output lead which is connected to both the non-linear high-power amplifier and to the high-frequency transmitter control amplifier. A mode selection signal, for designating either an analog or digital type transmission mode is applied to a mode control circuit that is responsive to the mode selection signal and provides switching signals to the first and second switches and a control signal to the linear amplifier. The mode selection signal sets the transmitter to function in either the non-linear transmission (analog) mode or the linear transmission (digital) mode.

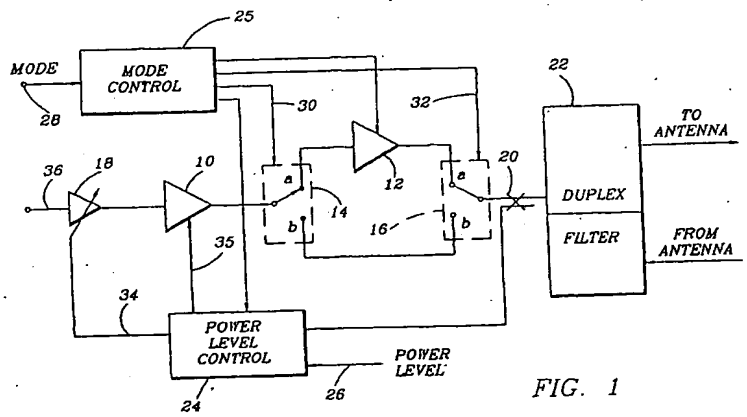

FIG. 1

EP 0 675 605 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 30 2103

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US 5 175 871 A (KUNKEL L P) 29 December 1992 * abstract * * column 2, line 63 - column 3, line 12 * * column 4, line 13 - line 34 * * figure 1 * * claim 1 *	1-10	H04B1/40 H04B7/005
A	US 5 179 353 A (MIYAKE ATSUSHI) 12 January 1993 * abstract * * column 2, line 52 - column 3, line 6 * * figure 1 *	1-10	
A	WO 93 18590 A (MOTOROLA INC) 16 September 1993 * abstract * * page 3, line 14 - page 7, line 21 * * figure 1 * * claims 1,9 *	1-10	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6) H04B H03F H03G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 May 1999	Tzimeas, K

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 95 30 2103

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-05-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5175871 A	29-12-1992	CA 2075588 A	09-02-1993
		JP 5199127 A	06-08-1993
		SE 9202292 A	09-02-1993
US 5179353 A	12-01-1993	JP 2703667 B	26-01-1998
		JP 4235401 A	24-08-1992
WO 9318590 A	16-09-1993	BR 9305438 A	02-08-1994
		CA 2108461 A	14-09-1993
		CN 1076566 A,B	22-09-1993
		GB 2270433 A,B	09-03-1994
		JP 6507775 T	01-09-1994
		MX 9301365 A	01-09-1993
		US 5438684 A	01-08-1995

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

THIS PAGE BLANK (USPTO)